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SHEAR CONTROLLING APPARATUS FOR AN EXTRUDER

TECHNICAL FIELD

The present invention relates to a shear controlling apparatus of the kind set forth in the preamble of claim 1 and a method of operating said apparatus.

BACKGROUND ART

From US-5,700,510 it is known to provide a variable restriction between the screw conveyor and the die plate in an extruder, said variable restriction providing a possibility of controlling the shear in the screw conveyor, and thus the mechanical energy delivery to the product in the screw conveyor of the extruder. However, this variable restriction provides a non-symmetrical restriction, which causes turbulence and uneven distribution of the flow through the restriction and through the different openings in the die plate, which will lead to non-uniform products produced by the extruder unless special configurations of the end of the extruder or pumping device are made. Such configurations are typically not contributing to any improvements of the product quality. A symmetrical and laminar flow is essential in order to obtain and even pressure at all die holes. Therefore it is preferred to use a spacer ring after the restriction before the die plate in order to stabilise the material flow.

BRIEF DESCRIPTION OF THE INVENTION

Based on this prior art, it is the object of the present invention to provide an extruder comprising a screw conveyor or any other pumping device in which the above problem is solved, and this is achieved by the features set forth in the characterising clause of claim 1. By having a restriction, which provides a symmetrical flow through the restriction, the flow to the die plate can be kept laminar and symmetrical and thus, a uniform flow is provided through all of the openings of the die plate, resulting in uniform products.

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Preferred embodiments of the invention, the advantages of which will be evident from the following detailed description, are revealed in the sub-ordinate claims.

BRIEF DESCRIPTION OF THE DRAWINGS

In the following detailed part of the present description, the invention will be explained in more detail with reference to the exemplary embodiments of a shear controlling apparatus for an extruder according to the invention shown in the drawings, in which

Figure 1 schematically shows an extruder, in which the present invention can be implemented, and

Figures 2-7 show the individual components of a preferred embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The extruder apparatus 1 shown in Figure 1 comprises a barrel 2 in which a screw conveyor 3, 4 is positioned for rotational movement in order to pump the material to be extruded from the inlet hopper 5 towards the outlet 6. The extruder outlet 6 is normally provided with a series of components ending up in a die plate comprising a number of holes through which the material is extruded, and possibly a rotating knife rotating along the outer surface of said die plate, for cutting off the extruded material, for providing suitably equally sized pellets of extruded material.

An extruder of this type can be used for producing different types of food and feed products, but in principle all products in which a viscosity change is requested by means of shear, using different raw materials introduced through the inlet funnel 5, which raw material is subjected to shear by the conveying means 2, 3, 4, whereby it is heated for cooking inside the barrel 2, and the shear can be increased by inserting stationary shear locks between separate sections of the screw conveyor 3, 4. Furthermore, different components inserted between the conveying means 2, 3, 4 and the die plate (not shown) can be used for increasing the pressure against which the conveying means works, thus increasing the shear in the extruder. It is also

possible to introduce steam into the barrel 2 or to heat the barrel from the outside by means of suitable heating elements positioned along the barrel 2.

It is obvious for a man skilled in the art that the screw conveyor shown in Figure 1 may be substituted by any other type of conveyor providing a pumping function and a kneading and shear providing function, corresponding to the pumping, shear and kneading function provided by the screw conveyor 3, 4. Furthermore, the screw conveyor may consist of several screws, typically two screws, but additional screws can also be provided.

In order to provide a dynamical control of the shear, to which the material is subjected during its conveyance through the conveying means 2, 3, 4, a variable restriction is positioned between the conveying means 2, 3, 4 and the die plate.

In accordance with a preferred embodiment, the variable restriction is provided by means of the components shown in Figures 2-7, as described in the following.

The variable restriction comprises a die neck, shown in Figure 5, which is an annular insert comprising a circular opening, through which material is delivered from the conveying means 3, 4. In front of this annular insert is mounted a die base insert, shown in Figure 3 in cross-section and in Figure 6 in front elevational view, said die base comprising radially extending plate-formed spokes or vanes connecting a central mainly circular part and an annular ring-formed outer part, said plate-formed spokes allowing the material to pass through the die base in the axial direction and reducing possible rotational movement of the material imposed by the conveying means 2, 3, 4. In the central circular part of the die base there is mounted a piston, shown in Figure 3 and Figure 7, for axial movement, whereby said piston can be moved in its position relative to the circular opening in the die neck shown in Figure 5, said axial movement of the piston controlling the opening between the piston and the circular opening in the die neck. After mounting the piston shown in Figure 3 in the central part of the die base shown in Figure 4, an end plate shown in Figure 2 is mounted on the die base for closing the piston cylinder unit, which is used to move the piston shown in Figure 3 inside the central part of the die base. Suitable hydraulic connections are provided in the die base, said hydraulic connections being formed inside the radially extending plate-formed spokes, whereby hydraulic fluid

can be supplied and withdrawn from the two sides of the hydraulic drive system for the piston.

It will be evident for a man skilled in the art that the above described variable restriction can be constructed in many other ways without departing from the main principle, namely that the variable restriction is constructed to provide a symmetrical flow through the variable restriction. In the described embodiment, it is the piston shown in Figures 3 and 7, which is moved relative to the circular opening in the die neck, but a movement of the circular opening in the die neck relative to the piston could also be used for providing the variability of the restriction. In the embodiment shown and described above, the piston and the opening in the die neck are circular and the piston has a frusto-conical surface directed towards the circular opening, but other formations of the piston and the opening could be envisaged. Furthermore, the piston could be mounted in the die plate and the die base could be omitted in the construction.

By means of the variable restriction in accordance with the present invention, it is possible to provide a dynamical control of the shear in the screw conveyor or other conveying means used in the extruder, whereby it is possible to compensate for variations in the parameters for the raw material delivered to the extruder. It will thus be possible to provide a more precise control of the shear in the extruder, thus providing an improved utilisation of essential raw materials in the process and an improved functionality of the raw materials resulting in improved product quality.

Preferably, the variable restriction is adjusted in such a way that a predetermined power delivery to the conveying means can be maintained, and furthermore, it is possible to measure the pressure inside the extruder and the flow of material, in order to optimise the process parameters for the extrusion process, e.g. providing a constant relation between the power delivery to the conveying means and the flow rate of the material, or a constant relation between the power delivery to the conveying means and the meal viscosity of the material, etc.

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